Integrated Model-Based Fault-management System Design, Phase I

Completed Technology Project (2018 - 2019)

Project Introduction

An Integrated Model-based Fault-management System Design (IMFSD) environment for current-generation and future high-autonomy space systems is developed, which integrates and documents in one platform framework Fault Management (FM) design processes, models and products. The IMFSD covers FM requirements definition, and design specification, analysis, validation-and-verification (V&V), and documentation, enabling the connection of the associated processes and models to the corresponding elements of the host space system model-based design.

The integration of FM development life-cycle processes is achieved by means of a "design development, documentation, and assurance case" (D3AC) logic structure hosted within the IMFSD software platform, which provides active connectivity among all elements of the FM design, and with the evidences produced to demonstrate compliance with concept-of-operations (ConOps) and requirements.

In view of expected spacecraft-autonomy evolutions for which expanded FM operational capability and analytics will be needed, the IMFSD, in addition to established FM models like Fault Tree Analysis (FTA) and Failure Modes and Effects Analysis (FMEA), includes, or links to, logic-dynamic models – e.g., Dynamic Flowgraph Methodology (DFM) and Markov Cell-to-Cell Mapping Technique (Markov-CCMT) – that can extend FM analysis into the time-dependent-logic domain. Other potentially applicable state-of-the-art models from the field of machine-learning, like Bayesian Belief Networks (BBN), Neural Networks (NN), Fuzzy Logic (FL, and Influence Diagrams (ID), are also evaluated for evolutionary inclusion in the IMFSD.

Once demonstrated for NASA applications, the IMFSD will be transferable to the design of FM for the high-autonomy commercial systems that are presently being developed in the aeronautical and transportation fields. This provides a path for commercialization efforts that will be initiated during execution of the Phase I development project.

Anticipated Benefits

The IMFSD is applicable to Fault Management (FM) design for NASA satellites, planetary spacecraft, and space vehicles, also including probes, rovers, space-travel and human-habitat systems. It is also applicable to aeronautical systems, manned and unmanned, which are also the focus of NASA research and mission activities. The convergence of FM and System Health Management (SHM) functions in high autonomy systems makes the IMFSD highly applicable to the FM design of these systems..

The IMFSD is applicable to all space, aeronautical, and transportation systems of substantial complexity in their Fault Management requirements and design. This includes: Department of Defense and commercial satellites and space

Table of Contents

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

ASCA, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

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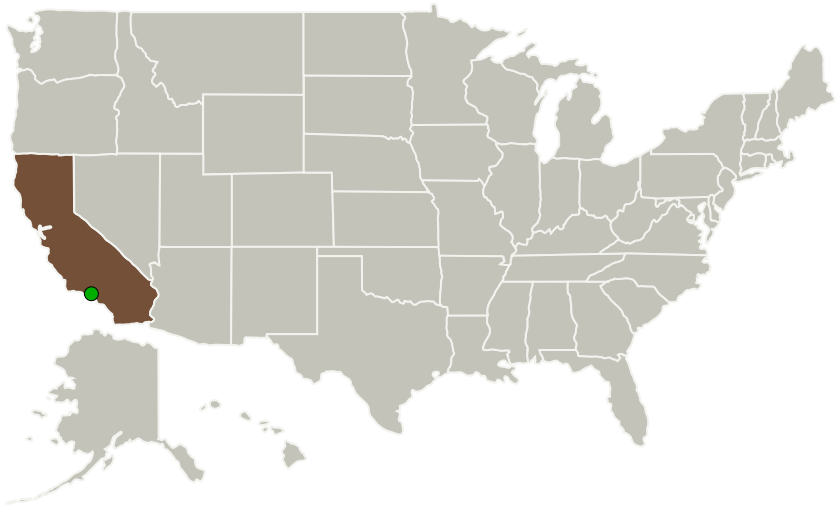
vehicle; Department of Defense and commercial aircraft and Unmanned Aerial Systems (UAS); driver-less automotive vehicles; semi-autonomous or autonomous marine vessels and probes.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
ASCA, Inc.	Lead Organization	Industry	Redondo Beach, California
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Transitions

July 2018: Project Start

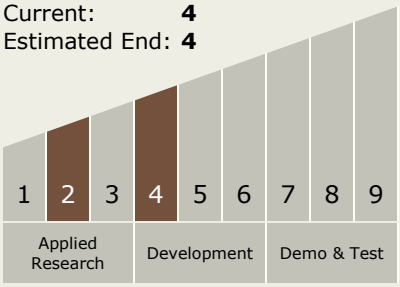
Project Management *(cont.)*

Program Manager:
Carlos Torrez

Principal Investigator:
Michael Yau

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX10 Autonomous Systems
  - TX10.2 Reasoning and Acting
    - TX10.2.5 Fault Diagnosis and Prognosis

Target Destinations

Earth, The Moon, Mars

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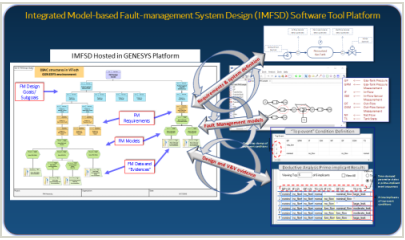
February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/137840)*

Images

Briefing Chart Image
Integrated Model-Based Fault-management System Design, Phase I
(https://techport.nasa.gov/image/127463)



Final Summary Chart Image
Integrated Model-Based Fault-management System Design, Phase I
(https://techport.nasa.gov/image/126538)